行政院國家科學委員會專題研究計畫　成果報告

流動性與價格發現之研究

計畫類別：個別型計畫
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一、摘要

本研究比較大台指期貨和小型台指期貨的日內價格發現，藉此檢驗流動性對相對價格發現的衝擊。文中利用資料配對方式切割流動性因素對價格發現的影響，發現大台指期貨的價格發現中約有 13%源自於其流動性(交易頻率較高)的優勢。此外，當大台指期貨交易量相對於小台指增加時，大台指呈現較強的資訊領先傾向。

關鍵詞：流動性、價格發現、資訊成分、小型指數期貨

Abstract

This article examines the impact of liquidity on relative rate of price discovery. We compare intraday price discovery between two futures contracts: the regular-sized Taiwan index futures (TX) and its mini contracts (MTX). Using data matching techniques to distinguish the impact of liquidity on price discovery, we find that a nontrivial portion (average 13%) of the TX information share can be attributable to its higher trading frequency. In addition, the information leading tendency of TX strengthens when the TX trading volume rises relative to the MTX volume.

Keywords: Liquidity, Price Discovery, Information Share, Mini Index Futures

I. Introduction

In an informationally efficient market, prices of financial assets reflect information available to market participants. If highly related financial assets are traded on more than one market, each market may be involved in the price discovery process. Given a choice between markets, an informed trader may evaluate the trade-off between liquidity, leverage and transaction costs for these different markets. The market provides a combination of the highest leverage, lowest transaction costs and greatest liquidity should dominate the price discovery because informed traders prefer to exploit their information advantage on such markets (Fleming, Ostdiek and Whaley, 1996; and Turkington and Walsh, 2000).

In searching for the determinants of price discovery, Fleming et al. (1996) find that the price discovery tends to first occur on the markets with lower brokerage commission and bid-ask spreads. The trading cost hypothesis is also supported by Kim, Szakmary, and Schwarz (1999), and Booth, So, and Tse (1999). The general consensus of these papers appears to suggest that the trading cost is the determinant for the relative rate of price discovery.

Equally important, but less investigated, is the impact of liquidity to the relative rate of price discovery. When multiple markets compete for price discovery, liquidity may affect the disclosure of information for several reasons. First, a liquid market offers better depth and immediacy. Trading based on new information is subject to shorter execution delay. Garbade and Silber (1983) suggest that price discovery is a function of the relative size of the market measured by the number of participants. Second, market impact costs are lower on a liquid market. In the theoretical model of Admati and Pfleiderer (1988), informed traders who like to minimize the market impact costs have incentive to trade when liquidity is greater. Informed traders therefore prefer to exploit their information on liquid markets. Finally, trading frequency may affect the measure of relative rate of price discovery. Prices of a frequently traded asset promptly impound new information, whereas the prices of a less liquid asset may lag the true value if there is no transaction to update the price. As a result, a liquid market may shows leading tendency to a less liquid market, particularly when price discovery is measured in fine time resolution.

In this article, we test whether trading frequency and trading volume influence the relative rate of price discovery between the TAIFEX traded regular-size (TX) and mini-index futures (MTX). The relative rate of price discovery is measured by the Gonzalo and Granger factor weights as well as the Hasbrouck information shares. We investigate the TX and MTX contracts because the similarities in contracts design and trading protocol reduce the number of potentially influential factors to their relative rate of price discovery. The simplification provides an opportunity to measure the impact of liquidity. Specifically, the study attempts to answer following questions:

1. Does greater trading frequency lead to a higher level of relative rate of price discovery?
2. Do trading volume and relative intensity influence the relative rate of price discovery?

To measure the impact of liquidity on price discovery of TX, we compare TX information share calculated from two samples compiled using different data matching techniques. The first sample retains all TX observations thus permits the full price discovery of TX, the second sample trims down the TX observations and forces TX to mimic the trading frequency of the less liquid MTX. Since the first sample incorporate the full price discovery of TX whereas the second sample restricts the TX price discovery as if it has the same trading frequency as MTX, the difference in TX information shares between two samples reflects the price discovery contributed by greater liquidity (trading frequency) of TX. Result suggests that about 13% of the TX price discovery can be attributable to its higher trading frequency.

We further explore the influence of trading volume to the daily information share using a regression framework. Result shows increased TX information shares when overall volume is high and when TX volume rises relative to MTX volume.

The remainder of the paper is organized as follows. Section II reviews the literature. Section III outlines the background of the TX and MTX markets. Section IV describes the data and the algorithms used to construct matched samples. In section V, we present the relative rate of price discovery of regular-TX and mini-TX. The proportion of price discovery attributable to the greater trading frequency of TX is summarized. In section VI, we investigate whether the day-to-day changes of price discovery can be explained by proxies of trading intensity. Section VII concludes the paper.

II. Data, Sampling Procedures, and Methodologies

This study employs tick-by-tick trade data provided by the TAIFEX from April 10, 2001 to April 19, 2002. A price is recorded at the time of transaction and is time stamped to the nearest second. To ensure sufficient observations, we use prices only from the nearby contracts. Upon three trading days prior to the expiration, we roll over the nearby contract to the next nearby contract. The nearby contracts are actively traded, with average daily volume 24,555 for TX and 4,917 for MTX. In terms of trading frequency, the TX has average 1,625 transactions and the MTX has 1,032 transactions in a trading day.

Since the transactions of TX and MTX do not occur exactly at the same time, a matching algorithm is necessary to pair up the two price series. This study forms two samples using different matching algorithms: sample 1 follows the approach used in Hasbrouck (1995) and sample 2 adopts the MINSPAN method invented by Harris et al. (1995). Figure 1 provides a simplified illustration for the matched results using two algorithms.

The Hasbrouck approach first expands each of the TX and MTX trade series into second-by-second price series. If there is no price reported at a particular second, the previous available price is used. The two expanded series then are merged according, producing a second-by-second matched sample. Since this procedure uses all available TX data, sample 1 fully reflects TX's advantages in both higher trading frequency and lower trading costs.

Sample 2 applies the MINSPAN method to remove the advantage of TX price discovery resulting from more frequent transaction. The MINSPAN method first identifies every available MTX price, and then searches for the nearest (in time) TX price to match with the identified MTX price. In other words, a matched pair is formed whenever there is a MTX trade. This process uses all available MTX data (the lower-frequency series) but dismisses some TX trades which occurred between two adjacent MTX trades. By trimming off the inter-temporal TX prices, the MINSPAN method in effect forces the TX series to mimic the trading intensity of the less-frequently traded MTX. After removing the TX's advantage in trading frequency, sample 2 reflects the price discovery of TX only attributable to its advantage in lower trading costs.

Since sample 2 is formed by removing the advantage of liquidity-induced price discovery in TX whereas sample 1 fully retains TX's overall information advantage, the difference in TX's price discovery between sample 1 and sample 2 could reflect the extent to which the additional trading intensity impacts upon the price discovery of TX.

The relative rate of price discovery of TX and MTX is measured by the Gonzalo and Granger (1995)'s factor weight model and the Hasbrouck (1995) information shares. Both models calculate relative weights of price discovery attributable to the component markets, with weights summing to one. The Gonzalo-Granger factor weight (hereafter FW) reflects the contribution of each series to the common implicit efficient price to all markets. The Hasbrouck information share (hereafter IS) decomposes the variance of efficient price innovations into components attributable to the innovation from each market. Since each model has its own merits and potential limitations, this study follows the suggestion of Lehmann (2002) by reporting both.

We perform price discovery calculation for each day separately and then averages the resulting FWs and ISs across days. The daily FWs and ISs can be used to examine the changes of price discovery between two markets over time. The time series of FW and IS also permit the investigation of how the daily variation of potential determinants affects the relative rate of price discovery. For Hasbrouck information shares, we calculate the upper and lower bounds of IS by changing order of TX and MTX in the Cholesky decomposition.

III. The Impact of Trading Frequency to the Price Discovery

Table 3 summarizes the daily Gonzalo-Granger factor weights (FW) in panel A and Hasbrouck information share (IS) in panel B. For sample 1, the average FW is 91.2% for TX versus 8.8% for MTX, suggesting that the regular TX contract makes a dominant contribution to the long-term stochastic trend. It also shows that 50% of the daily TX factor weights are above 92.3%. The last row in panel A shows that TX has higher daily FW in all of 246 trading days. Since sample 1 is comprised such that all available TX observations are used, the greater price discovery of TX than MTX in this sample can be attributable to TX's joint advantages in lower trading costs and higher trading frequency.

In sample 2, the inter-temporal TX prices are discarded so that the TX trading frequency mimics that of MTX. The regular contract still makes substantially greater contribution (77.8%) in price discovery than the mini contracts (22.2%), although the difference is not as dramatic as in sample 1. Since this sample is formed to equalize the liquidity of two contracts, the greater TX factor weights than MTX in this sample are attributable to the lower trading costs of TX. This result confirms the findings of Fleming et al. (1996), Kim et al. (1999), and Min and Najand (1999) that the market with lower direct trading costs tends to lead the process of price discovery.

The last column of Panel 1 reports the magnitude of liquidity impacts on the relative rate of price discovery. Since sample 1 measures the full price discovery of TX whereas sample 2 incorporates only the TX price discovery resulting from the advantage in trading costs, the difference in TX's FW between two samples reflects the component of TX price discovery attributable to TX's advantage in liquidity. The last column of Panel 1 shows that there is an average 13.4% increase in the FW when inter-temporal TX prices are included. Also shown by the 50% quartile, the inclusion of liquidity effect adds more than 11% of FW for half of the sample days. The significant difference in TX factor weights with and without the liquidity advantage suggests that, in addition to the effect of trading costs, liquidity also accounts for a nontrivial portion of price discovery.

Panel B reports TX and MTX price discovery measured by the Hasbrouck information share. Similar to previous FW measure, we find evidence consistent with both the liquidity effect and trading costs hypothesis. In sample 2 where trading frequency in two series is equalized, the TX contribution to the innovation of common trend ranges from 80.6% (the lower bound) to 89.6% (the upper bound). It suggests that a considerably higher percentage of information is originated from the regular contract than from the mini contract. This superiority of TX price discovery is solely attributable to its advantage in transaction cost. In sample 1 for which the interim TX prices are included, the daily TX information shares are within the range between 97.4% and 97.6%, which indicates an average 8% to 16.8% increase from sample 2. This improvement of TX price discovery is approximately the same in magnitude as the 13.4% increase of TX's FW in panel A. Evidence again shows that a nontrivial portion of TX price discovery is associated with its higher trading frequency.

The finding of significant liquidity impact on price discovery is consistent with the recent studies regarding competition of information flows between CME traded regular index futures and E-mini contracts. Both Kurov and Lasser (2004) and Ates and Wang (2005) report significant price leadership in the E-mini contracts relative to their correspondent regular contracts. The trading costs for E-minis and regular contracts is indistinguishable depending on trade size, however, the E-mini contracts clearly enjoy substantially higher trading frequency. The substantial liquidity impact of TX price discovery parallels the finding of E-mini's stronger information role such that the greater liquidity leads to better price discovery.

VI. Price Discovery and Trading Intensity

Chan (1992) suggests that, during periods of higher trading activity, the already dominant market should exhibit increasingly leading tendency. This is because when there is substantial information impact (proxied by greater trading activity), there is increasing need for information trading. Since informed traders prefer the low cost and high liquid markets, the clustering of information trading on the dominant market further enhances its leading tendency over the satellite market. Our test, therefore, concerns whether TX price discovery enhances during periods of intensive trading activity.

A time series regression model similar to that in Ates and Wang (2005) is used to examine if the daily TX price discovery is positively associated with proxies of trading activity. The regression model is specified as:

$$TXdiscovery_t = \beta_1 + \beta_2 Tvolume_t + \beta_3 Rvolume_t + \beta_4 trend_t + \varepsilon_t \quad (1).$$

The dependent variable (*TXdiscovery*) is the daily TX price discovery measured by Gonzalo-Granger factor weight (FW) and the upper and lower bound of Hasbrouck information share (IS^U and IS^L). For independent variables, we use two proxies of trading intensity: the total volume (*Tvolume*) defined as the sum of daily TX and MTX volume; and the relative volume (*Rvolume*) defined as the daily TX volume divided by the MTX volume. The *Tvolume* reflects the magnitude and intensity of information impact to both markets. The *Rvolume* measures the trading activity (possibly caused by informed trading) of TX relative to that of MTX. Since our sample corresponds to the period of growing MTX market, a trend variable is included to account for the possible changing MTX price discovery over time.

Coefficients are estimated using GMM approach, which provides consistent statistic inferences in the presence of conditional heteroskedasticity and autocorrelation. We perform the regressions using TX price discovery calculated from sample 1, sample 2, and the difference between two samples (sample 3) as dependent variables. They respectively represent the overall TX price discovery, the TX price discovery associated with TX's advantage in trading costs, and the liquidity impact of TX price discovery.

Results are summarized in Table 4. For sample 1 regressions, the TX price discovery is positively related to trading volume and relative volume, and negatively related to the trend variable. All coefficients are significantly different from zero under 1% critical value. The positive coefficient of total volume confirms Chan (1992)'s conjecture that greater trading activity enhances the information processing of the already leading market in price discovery. Kurov and Lasser (2004) investigate the price discovery between the CME traded E-minis and regular contracts and find that at beginning of a trading day, when more information comes in and intensive transaction takes place, the already dominant E-mini contracts shows stronger information share than during the rest of the day. Our evidence echoes Kurov and Lasser (2004)'s findings and suggests that during periods of intensive information, traders tend to exploit their information using the cheaper and more liquid TX contract, which, in turn, further strengthens the price discovery of this already dominant market.

Coefficients of relative volume are significantly positive for all sample 1 regressions. It indicates that when two or more markets compete for information flows, an increasing volume relative to the counterpart volume is associated with better relative rate of price discovery. Result is consistent with Ates and Wang (2005), who find the E-minis information shares increases when the trading intensity on E-minis increases faster than that on the regular-sized contract.

Finally, the coefficient of trend variable is significantly negative, indicating a downward (upward) trend of TX (MTX) price discovery in our sample period. Since the data covers the first year of MTX trading, the rising MTX price discovery is consistent with the steady growth of MTX trading activity in our sample period.

Results of sample 2 regressions are largely consistent with sample 1 regressions, although some coefficients are less significant. Note that the dependent variable reflects only the component of TX price discovery associated with its advantage in trading cost. The positive volume coefficients suggest that, when information impact is intensive, the low-cost market exhibits increased relative rate of price discovery, perhaps because more traders seek to exploit information on the low-cost markets.

In sample 3 regressions, coefficients of total volume and relative volume are in general statistically insignificant. The insignificant coefficient implies that the TX price discovery resulted from excess trading frequency is less relevant to the changes of trading volume or the relative volume over time. We also note that the sample 3 regressions have the lowest adjusted R-squares among three groups of regression. It seems that the variation of trading volume over time affects the price discovery associated with direct transaction costs but not the price discovery associated with trading frequency.

VI. Conclusions

This article examines the impact of liquidity to the relative rate of price discovery. Using the regular-sized Taiwan index futures (TX) and its miniature contract (MTX), we measure the impact of liquidity by comparing the TX price discovery obtained from two matched samples, one incorporates all available TX trade prices, the other removes the advantage of higher trading frequency of TX. Results show that about 13% of the TX information share and factor weight can be attributable to its advantage in greater trading frequency. The nontrivial portion of liquidity impacts on price discovery is consistent with the recent findings on the U.S. market that the better liquid (but not necessarily lower cost) E-minis has stronger information role than the regular-sized counterparts.

A time series regression further demonstrates that the degree of TX price discovery is positively related to the overall trading volume and relative TX volume over MTX volume. It suggests that the variation in trading volume over time significantly influences relative rate of price discovery.

Table 3 Summary of Factor Weights and Information Shares

The Gonzalo-Granger (1995) factor weights (FW) and the Hasbrouck (1995) information shares (IS) are estimated for every individual trading day using intraday trade prices. Sample 1 first expands both original data into second-by-second series by filling the missing data with the prevailing price and then merges two series by their time stamps. This sample contains the full price discovery of TX. Sample 2 matches every available MTX price to a nearest TX price, which removes the liquidity advantage of TX. The table reports summary statistics of 246 daily information shares (upper bound and lower bound in cases of Hasbrouck information share). The impact of liquidity is the differences of TX information shares (factor weights) between two samples. “TX>MTX” indicates the number of trading day for which the TX’s IS (FW) is greater than the MTX’s IS (FW).

Panel A: Gonzalo-Granger Factor Weight (FW)

	Sample 1		**Sample 2**		**Liquidity impact**
	TX	MTX	TX	MTX	TX_{samp1}-TX_{samp2}
mean	0.912	0.088	0.778	0.222	0.134
std	0.072	0.072	0.169	0.169	0.162
max	1.000	0.465	0.994	0.971	0.874
min	0.535	0.000	0.029	0.006	-0.243
75% quartile	0.964	0.121	0.893	0.306	0.207
50% quartile	0.923	0.077	0.814	0.186	0.110
TX>MTX	246 days		229 days		

Panel B: Hasbrouck Information Share (IS)

	Sample 1		**Sample 2**		**Liquidity impact**
	TX	MTX	TX	MTX	TX_{samp1}-TX_{samp2}
Upper bound					
mean	0.976	0.026	0.896	0.194	0.080
std	0.045	0.046	0.151	0.200	0.138
max	1.000	0.365	1.000	0.943	0.738
min	0.638	0.000	0.248	0.003	-0.233
75% quartile	0.998	0.030	0.993	0.255	0.099
50% quartile	0.990	0.011	0.962	0.124	0.023
TX>MTX	246 days		231 days		
Lower bound					
mean	0.974	0.024	0.806	0.104	0.168
std	0.046	0.045	0.200	0.151	0.184
max	1.000	0.362	0.997	0.752	0.937
min	0.635	0.000	0.057	0.000	-0.065
75% quartile	0.997	0.026	0.948	0.129	0.218
50% quartile	0.989	0.010	0.876	0.038	0.106
TX>MTX	246 days		231 days		

Table 4 Determinants of Information Contribution

Daily information contributions are regressed against total volume, relative volume, and a trend variable in following regression framework:

$$TXdiscovery_t = \beta_1 + \beta_2 Tvolume_t + \beta_3 Rvolume_t + \beta_4 trend_t + \varepsilon_t$$

Price discovery (dependent variable) is either the Gonzalo-Granger factor weight (FW), the upper bound of Hasbrouck information share (IS^U), or the lower bound of Hasbrouck information share (IS^L). *Tvolume* is the sum of daily TX and MTX volume. *Rvolume* is the daily TX volume divided by MTX volume. Parameters and t-values (in parentheses) are estimated using the GMM procedure to obtain consistent estimates under serially correlated and heteroskedastic error terms.

	Sample 1			**Sample 2**			**Sample 3: Liquidity component**		
Dep. Var.	**FW**	**IS^U**	**IS^L**	**FW**	**IS^U**	**IS^L**	**FW**	**IS^U**	**IS^L**
intercept	**0.277**	**0.642**	**0.635**	0.041	0.368	-0.179	0.235	0.274	**0.814**
	(2.42)	**(8.82)**	**(8.34)**	(0.12)	(1.74)	(-0.63)	(0.76)	(1.33)	**(3.05)**
Tvolume	**0.061**	**0.031**	**0.032**	**0.071**	**0.043**	**0.082**	-0.011	-0.012	-0.050
	(5.60)	**(4.54)**	**(4.41)**	**(2.36)**	**(2.23)**	**(3.09)**	(-0.39)	(-0.67)	(-1.05)
Rvolume	**0.333**	**0.231**	**0.231**	-0.005	0.550	**1.044**	0.337	-0.319	-0.813
	(2.11)	**(2.60)**	**(2.46)**	(-0.01)	(1.73)	**(2.49)**	(0.85)	(-1.04)	(-1.05)
trend	**-0.00036**	**-0.00022**	**-0.00023**	0.00012	-0.00017	-0.00043	**-0.00048**	-0.00005	0.00020
	(-4.28)	**(-4.42)**	**(-4.29)**	(0.63)	(-0.90)	(-1.80)	**(-2.58)**	(-0.27)	(0.87)
Adj. R^2	12.72%	9.01%	8.87%	5.23%	1.64%	3.88%	2.77%	0.32%	2.20%
dw	2.15	1.99	1.94	2.19	1.98	2.00	2.13	1.99	1.99